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TECHNICAL MEMORANDUM

Pump Station Upgrades/ Pressure-reducing Stations

PREPARED FOR: City of Santa Rosa

PREPARED BY: John Crowe/CH2M HILL

REVIEWED BY: Ted Whiton/Winzler & Kelly
Dave Coleman/Winzler & Kelly
Jane Rozga/CH2M HILL
Anne Kernkamp/CH2M HILL

COPIES: Dave Smith/Merritt Smith Consulting
Mark Millan/Data Instincts
Pat Collins/Winzler & Kelly

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Background and Purpose

The Santa Rosa Urban Reuse Project (SRURP) is part of the Incremental Recycled Water Program (IRWP). The primary Project objective is to provide urban reuse capacity of 1,000 million gallons (MG) of recycled water per year in Santa Rosa for the Subregional Water Reuse System.

The purposes of this technical memorandum are as follows:

- Describe the improvements needed to existing pumping facilities to meet the future needs of the SRURP.
- Identify opportunities to utilize the energy that would be released by the pressure drop required if serving the SRURP from either the Rohnert Park Urban Reuse System or from the Geysers Pipeline (GPL).

This technical memorandum includes the following sections:

- Background and Purpose
- Conclusions and Recommendations
- Llano Pump Station Improvements
- Rohnert Park Pump Station Improvements
- Alpha Farm Pressure-reducing Station
- Roberts Lake Road Pressure-reducing Station

- Power Production
- Optional Connection to the Laguna Subregional Water Reclamation Facility (Laguna Plant)

An overview of the geographic location of new facilities is shown on Figure 1.

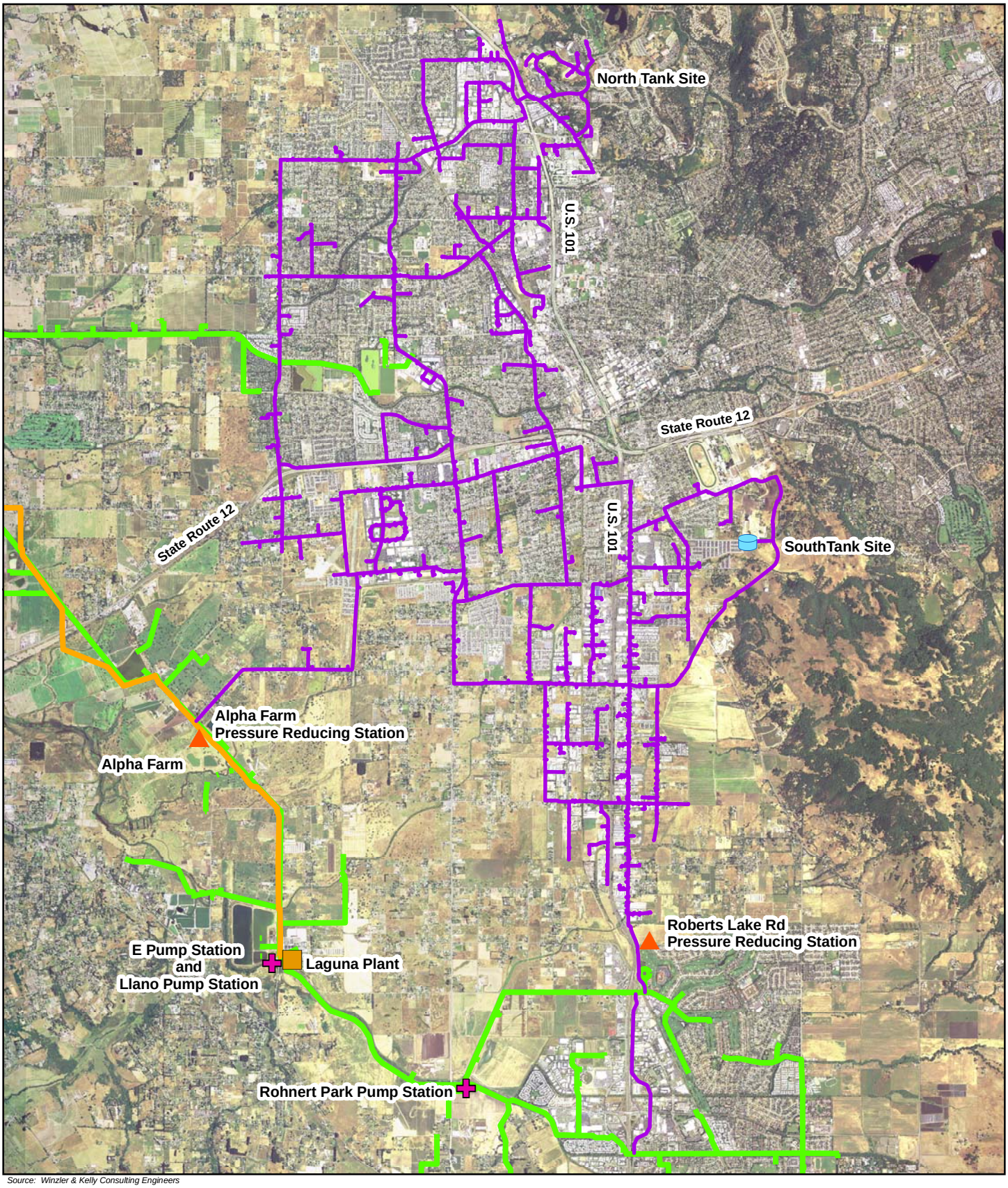
Conclusions and Recommendations

To meet the needs of the SRURP, the capacity of Llano Pump Station must be increased by 14 million gallons per day (mgd), and Rohnert Park Pump Station capacity must be increased by 2 mgd. Both Llano Pump Station and Rohnert Park Pump Station can easily be expanded to meet these requirements. At Llano Pump Station, installation of two new pumps in previously constructed spaces would provide the additional capacity. At Rohnert Park Pump Station, modification would include one new pump, a small amount of piping and auxiliary equipment, and an extension of the sound wall. The proposed Project would utilize only part of the planned future capacity of the pump stations. If required, each could easily be expanded again.

To supply the storage tanks in the Santa Rosa hills, the SRURP would receive recycled water from the GPL in the west and from the Rohnert Park Urban Reuse System in the south. The pressure in the GPL must be reduced 45 to 140 pounds per square inch (psi) for transmission across the City of Santa Rosa (City). The pressure in the Rohnert Park system would have to be reduced approximately 45 psi.

An alternative to a conventional pressure-reducing station would be a hydroelectric generating station that generates power as it reduces pressure. A hydroelectric station on the feeder from the GPL could generate approximately 250,000 kilowatt-hours for each 1,000 MG of recycled water used. The station would normally generate power during off-peak hours. Pacific Gas and Electric Company currently pays approximately $0.05 per kilowatt-hour, so a hydroelectric facility would produce gross revenue of approximately $13,000 annually. The hydroelectric station would cost approximately $2.0 million more than a conventional pressure-reducing station. The gross revenue would be less than 1 percent of the additional cost required to build the hydroelectric station. Therefore, economic benefits alone would not appear to warrant implementation of the hydroelectric facility.

To minimize the amount of water sent from the storage ponds to the SRURP, connection to the GPL has been preferred. Recycled water from the Laguna Plant could be diverted directly into this pipeline, thereby avoiding the ponds. With the recent implementation of the Geysers Expansion Project, more water from storage ponds will be diverted to the GPL during the summer, making this advantage less significant. As an alternative, the SRURP could be fed from the existing low-pressure recycled water pipeline that is parallel to the GPL along Llano Road. In either case, the SRURP would receive a blend of water from the Laguna Plant and storage ponds that would be filtered.



Source: Winzler & Kelly Consulting Engineers

Legend

- SRURP Pipelines
- Geysers Pipeline
- Existing Water Reuse System
- Proposed Storage Tank Sites
- Existing Pump Stations
- Proposed Pressure Reducing Station

0 2,500 5,000 Feet

FIGURE 1
SRURP FACILITIES

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Urban Reuse

City of Santa Rosa IRWP
Sonoma County, California

November 2007

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With this alternative, modifications to the Llano Pump Station would not be necessary. A new pump station would be required to boost the pressure from the recycled water pipeline to meet the requirements of the Urban Reuse System. The pump station could be located along Llano Road in the northeast corner of Alpha Farm adjacent to the filtration equipment. This alternative would require less power than supplying the SRURP from the GPL.

Llano Pump Station Improvements

Recycled water from the Laguna Plant is piped under Llano Road to a wet-well junction structure that supplies both E Pump Station and Llano Pump Station as shown on Figure 2. Llano Pump station currently supplies recycled water only to the GPL. E Pump Station supplies the Rohnert Park Urban Reuse System and other users. Modifications that will be required for the wet-well and E Pump Station are described in the Water Quality and Treatment TM.

Capacity Increase

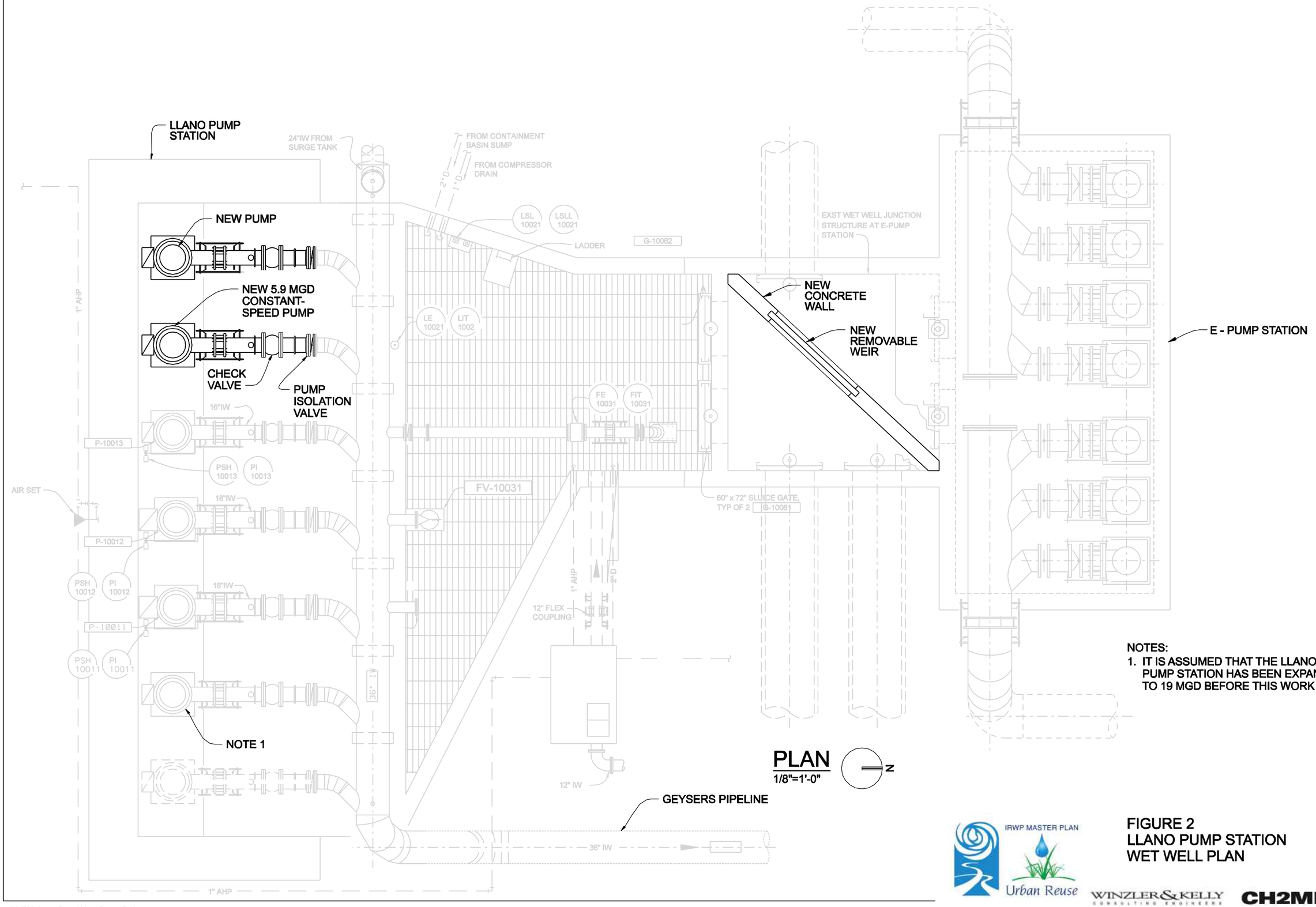
The Llano Pump Station was designed to pump 40 mgd. The pumps are outdoor vertical turbine pumps suspended above a wet well. Electrical and control equipment is installed in an adjacent building. Using a combination of variable-speed and constant-speed pumps, the pump station would pump a range of flows from 5 to 40 mgd. Initially, three pumps were installed, two 10.7-mgd variable-speed pumps and one 5.9-mgd constant-speed pump giving the pump station a firm capacity of 16.6 mgd. Space was provided for the future installation of four constant-speed pumps, each with a capacity of 5.9 mgd. Recently, the demand for flow to the Geysers increased from 11 mgd to 19 mgd. It will be necessary to install one more constant-speed pump to have adequate firm capacity to meet the increased demand. The installation should be completed by the time additional urban reuse capacity is needed. The SRURP is projected to have a demand of 14 mgd from the GPL, bringing the total demand on Llano Pump Station to 33 mgd. Installing two constant-speed pumps, as shown in Figure 2, would meet this demand.

Civil/Structural

The wet well was constructed with spaces for future pumps. The four existing pumps are in the center of the structure. Two new pumps would be installed as shown on Figure 2. No significant earthwork or structural modifications would be required to install two more pumps.

Mechanical

The anticipated expansion of the pump station to 40-mgd capacity would entail installing four more 5.9-mgd pumps identical to the existing constant-speed pump. If one 5.9-mgd pump is installed to bring Geysers pumping capacity to 19 mgd before the SRURP is constructed, two additional pumps of this size would provide slightly more capacity than the 14 mgd that is needed for the SRURP, but it would result in a pump station in which all of the constant-speed pumps are the same size and are operationally interchangeable. The hydropneumatic surge tank installed at Llano Pump Station during the initial construction was designed for flows up to 40 mgd. The increased flow in the pipeline resulting from the



NOTES:
1. IT IS ASSUMED THAT THE LLANO PUMP STATION HAS BEEN EXPANDED TO 19 MGD BEFORE THIS WORK BEGINS.

PLAN
1/8"=1'-0"

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FIGURE 2
LLANO PUMP STATION
WET WELL PLAN

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Urban Reuse System can be accommodated with no modifications to the surge control system.

Electrical and Controls

The electrical system at Llano Pump Station was designed for expansion. Electrical work to expand the Geysers pumping capacity to 19 mgd will be completed before additional urban reuse capacity is needed. Two new reduced-voltage, solid-state motor starters can be installed in the space provided in the Motor Control Building. Figure 3, the single-line diagram for the pump station, shows how the new units would fit into the existing electrical system. As part of the initial construction, conduits were installed from the Motor Control Building to the pump pads at the locations shown for the proposed pumps.

The pump controls were designed to allow variable flow rates to the Geysers and, in addition, allow variable withdrawal rates from any point along the GPL between the Llano and Bear Canyon Pump Stations. The flow from Llano Pump Station is automatically adjusted to maintain a specific level in the wet well of the Bear Canyon Pump Station. When the rate of flow through the Bear Canyon pumps to the Geysers changes, the water level in the Bear Canyon wet well changes. The Llano pumping rate is then adjusted as necessary to return the Bear Canyon wet well level to its normal depth. Changing the amount of water withdrawn from the system between the Llano and Bear Canyon Pump Stations has the same effect; it causes a change in the wet well level, and the pumps at Llano react to that change.

No major modifications to the Llano Pump Station pump control system are required for the Urban Reuse System (Figure 4). Existing spare programmable logic controller (PLC) inputs and outputs can be used to interface to the new motor controllers. The PLC programming would need to be modified to include two new pumps in the sequence selection system and to add level setpoints for starting and stopping additional pumps using the Bear Canyon wet well level. The human-machine interface (HMI) screens would need to be modified to show the new pumps. The vibration monitoring system would need to be expanded to accommodate new pumps. Existing pump/motor instrumentation would be duplicated for the new units.

Cost

The cost of the proposed modifications to Llano Pump Station is estimated to be approximately $850,000 at 2007 prices.

Rohnert Park Pump Station Improvements

Capacity Increase

Like Llano Pump Station, the Rohnert Park Pump Station was designed with a combination of variable-speed and constant-speed pumps that would, at buildout, allow it to pump a wide range of flows up to 15 mgd. The pumps are outdoor vertical turbine pumps installed on buried suction cans. The electrical equipment and controls are housed in an adjacent masonry building. A masonry wall surrounds the pumps to reduce noise transmission to neighboring properties.

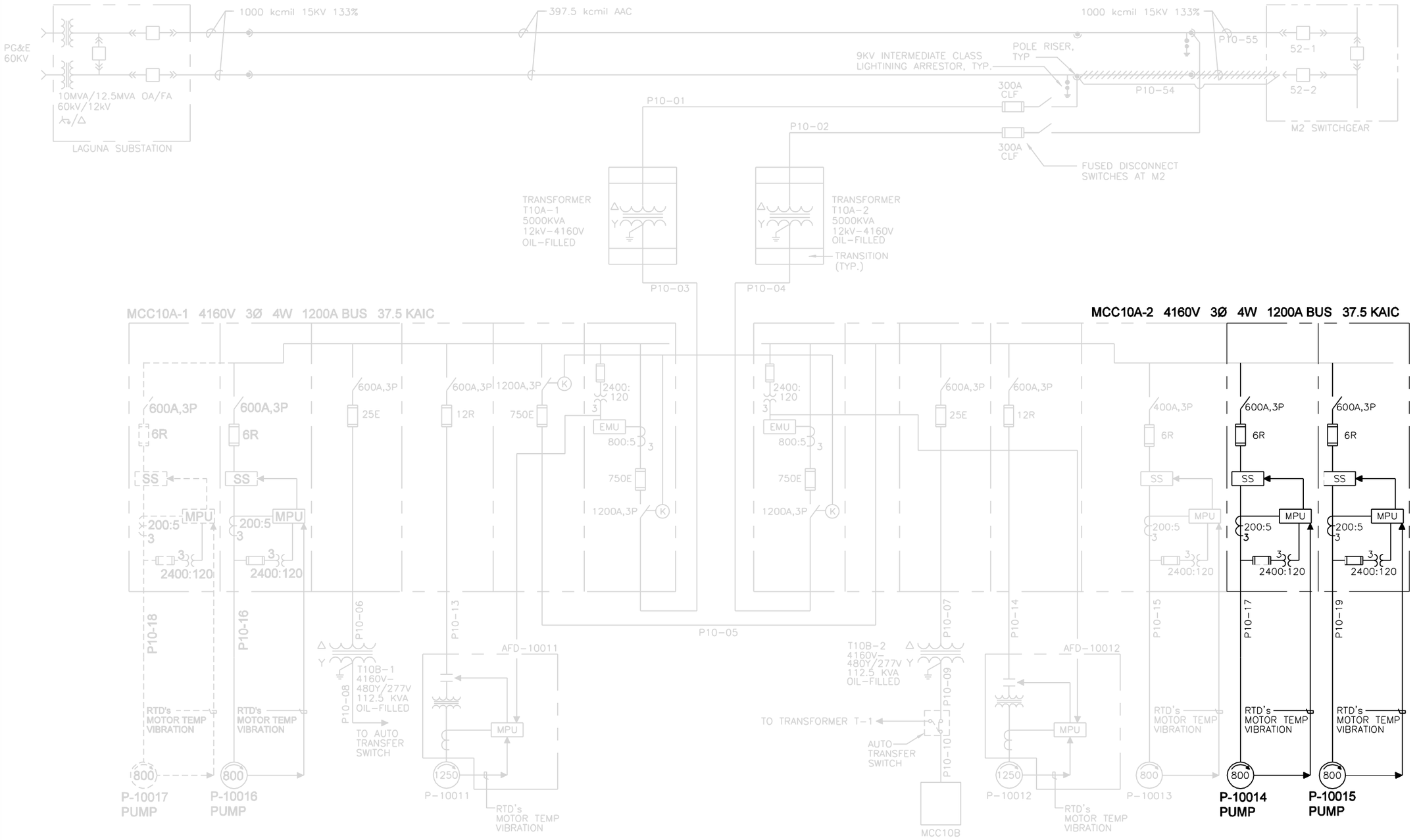

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FIGURE 3
LLANO PUMP STATION
SINGLE LINE DIAGRAM

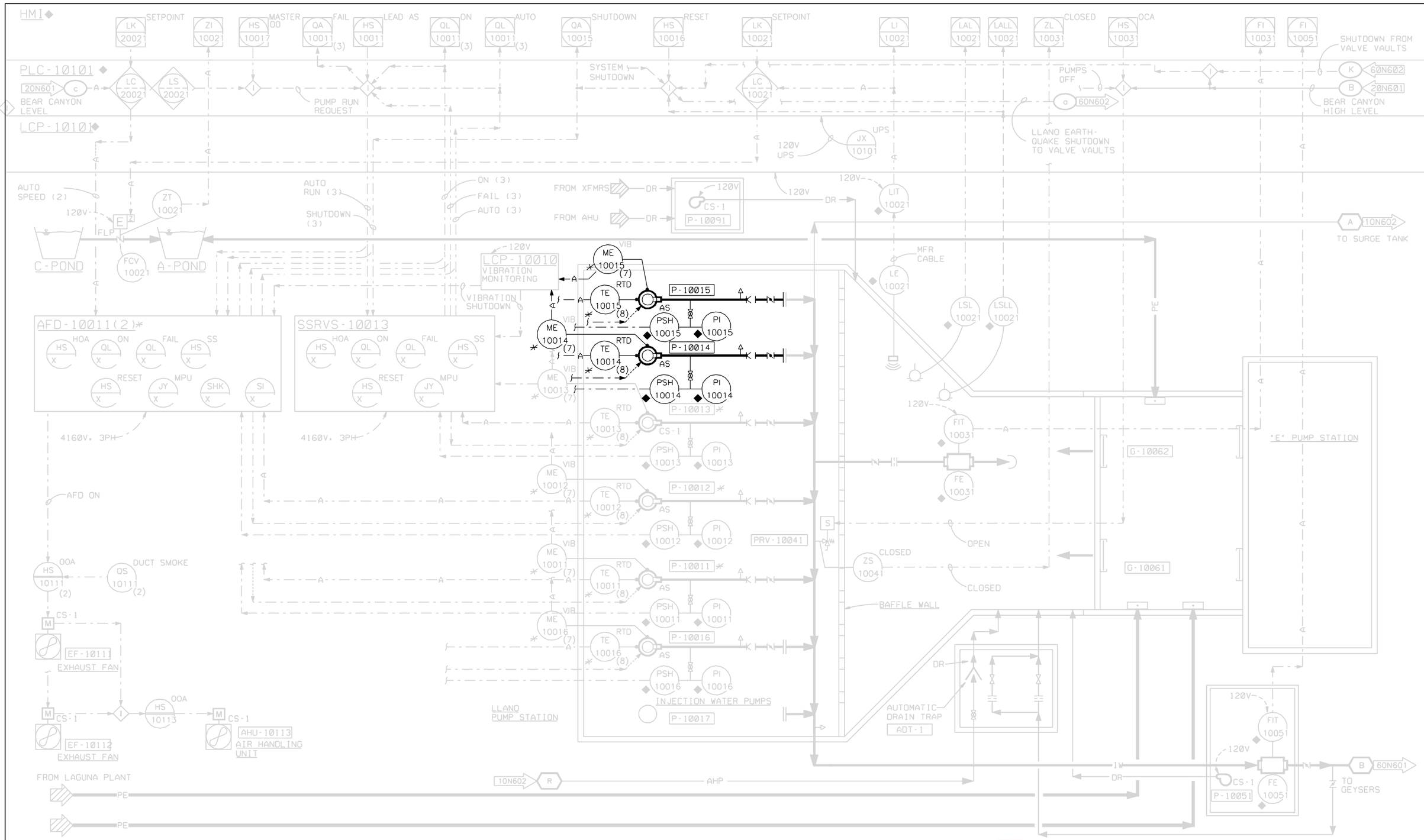

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FIGURE 4
LLANO PUMP STATION PROCESS FLOW DIAGRAM

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Initially, one constant-speed pump and two variable-speed pumps were installed. One of the variable-speed pumps provides redundancy. The variable-speed pumps have a capacity of 4.6 mgd each, and the constant-speed pump has a capacity of 3.5 mgd. The station currently has an operating range from 0.6 mgd to 8.1 mgd. To meet the demand of the Urban Reuse System, the pump station firm capacity should be increased to 10 mgd. Space was provided in the initial pump station configuration for three future pumps. Installing one 3.5-mgd pump would provide enough additional capacity to meet the demand of the Urban Reuse System.

Rohnert Park Pump Station has a hydropneumatic surge tank to control pipeline pressure fluctuations caused by power failure. The 1994 surge analysis indicated that the low-pressure 18-inch polyvinyl chloride piping that currently supplies recycled water to the Foxtail Golf Course, installed prior to the pump station, was the critical pipeline segment on the high-pressure side of the pump station. The steady-state pressure rating of the 18-inch pipe is only 125 pounds per square inch (psi). The surge tank was designed to keep the maximum surge pressure within 2 psi of the normal operating pressure with all six pumps in operation. The increased flow in the pipeline for the Urban Reuse System is less than the design flow for the discharge surge control system, so no modifications are required to the existing surge control system on the discharge side of the pumps.

The 1994 report, *Surge Control Equipment and Associated Surge Analysis of the Poncia Pond Pump Station and Rohnert Park Urban Reuse System* (CH2M HILL), indicated that with six pumps installed, power failures at the E Pump Station could cause high vacuum followed by high pressure in the pipeline from the E Pump Station that feeds Rohnert Park Pump Station. The report recommended installation of 3-inch vacuum valves at seven locations along the pipeline or, alternatively, hydropneumatic surge tanks at each pump station. The modifications to that pipeline were not included as part of the Rohnert Park Pump Station three-pump construction contract. The report does not specify if the surge tank would be necessary for fewer than six pumps. A surge analysis of this pipeline should be completed as part of the proposed expansion of the pump station to confirm that the installation of a single pump would not necessitate surge protection measures on the pipeline between E Pump Station and the Rohnert Park Pump Station. If a surge tank were required, it could be located as shown on Figure 5.

At Rohnert Park Pump Station, recycled water is filtered prior to entering the distribution system. The initial construction included five automatic backwashing pressure filters, each rated for 1,500 gallons per minute (gpm). If all existing filters are in service, the total capacity is 10.8 mgd. Installation of two new filters is proposed to enable the pump station to deliver the design flow of 10 mgd with one filter backwashing and another out of service. Filter backwash water from the new filters will be connected to the existing backwash system that discharges to the Laguna Plant via an existing sewer from Rohnert Park Pump Station.

Civil/Structural

No significant site grading or building modifications would be required. A new 24-inch-diameter buried supply line for the new pump would be constructed to the south of the existing pump discharge manifold, as shown on Figure 5. The south sound wall will be demolished, and the enclosure will be extended approximately 15 feet to the south.

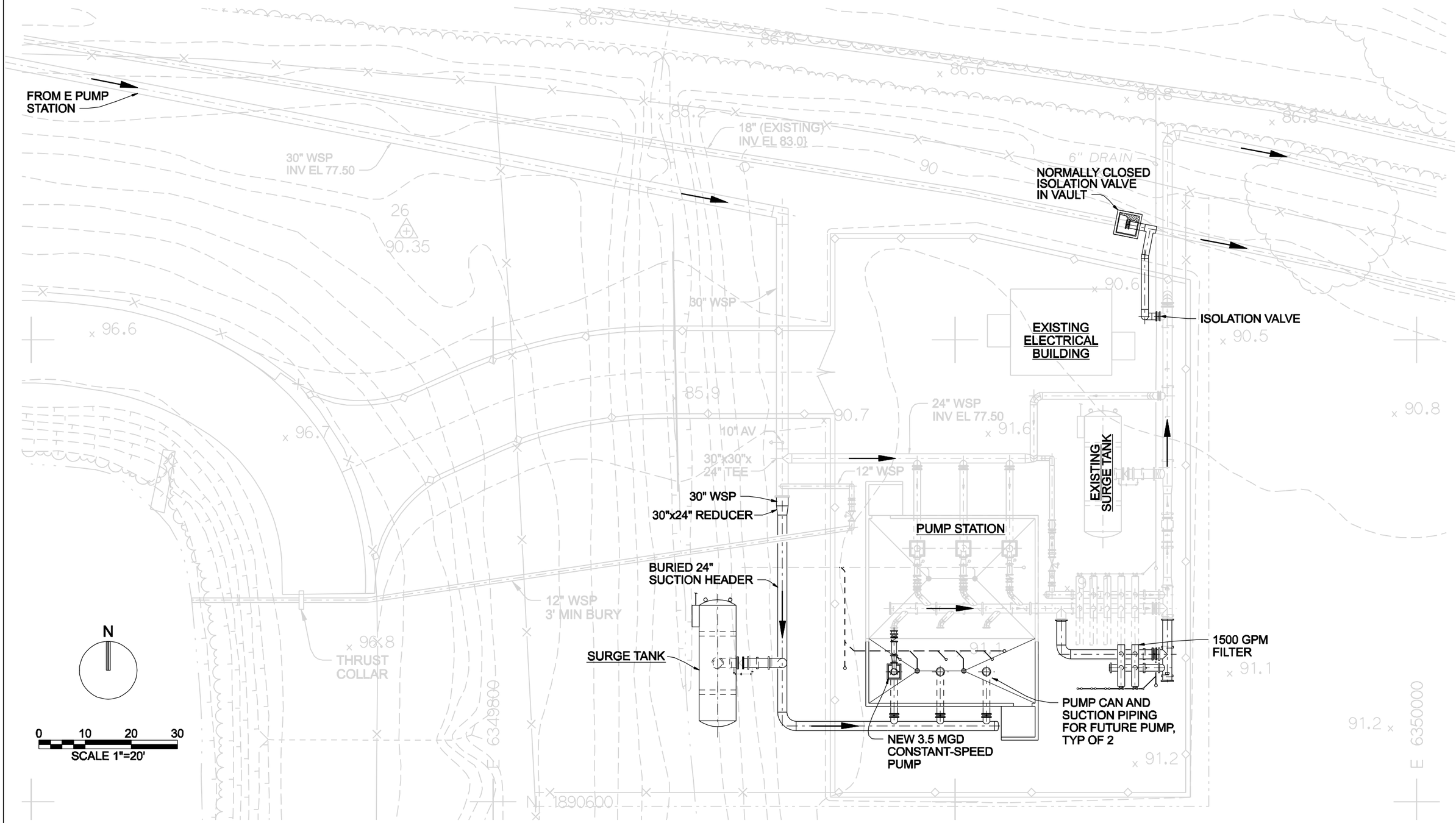

FIGURE 5
ROHNERT PARK PUMP STATION
SITE PLAN

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Mechanical

Like Llano Pump Station, Rohnert Park Pump Station was designed for a more extensive expansion than is currently proposed. The discharge header was built with spaces for three additional constant-speed pumps, 3.5 mgd each, but only one additional pump would be needed to meet the additional demand of the SRURP. To preserve the same degree of flexibility for future expansion provided in the original design, installation of suction piping and suction cans for all three pumps is recommended as part of this project. Installing these components would enable future addition of two more pumps without requiring demolition of the sound wall or trenching within the sound enclosure.

Although only 2 mgd of additional capacity is required, installation of a 3.5-mgd pump that matches the existing unit is recommended. Pump station operation would be simpler if both constant-speed pumps are the same size. In addition, a new 3.5-mgd pump would maintain the ultimate, originally planned future capacity of the pump station.

A new connection between the pump discharge header and the 18-inch recycled water line is shown on Figure 5 near the northeast corner of the Electrical Building. An isolation valve would be installed on the west side of the connection to the 18-inch line. The valve would be closed during normal operation. Currently, the 18-inch line is pressurized by the E Pump Station. The connection would allow the 18-inch line to be operated at the higher pressure of the Rohnert Park Pump Station and also allow it to serve some of the SRURP users in the southern part of the system. Because the pipeline that supplies the Foxtail Golf Course would not withstand the increased pressure, a pressure-reducing valve would be installed between the main and the branch to the golf course.

Electrical and Controls

The electrical system was designed to easily allow installation of as many as three additional pumps. The installation of a single pump would require a new reduced-voltage, solid-state motor starter similar to the existing units. Space is provided in the building for the new starter. All of the necessary under-slab conduits are in place, and buried conduits would only need to be extended slightly for the new unit. The single-line diagram for the pump station with the new reduced-voltage, solid-state starter is shown on Figure 6.

The control system can easily accommodate the new pump (Figure 7). Existing spare PLC inputs and outputs would be used to interface with the new motor controller. A new discreet output module may need to be added to the existing PLC rack. The PLC sequence logic must be programmed to include the new pump. It would also be necessary to duplicate other PLC and HMI pump control and monitoring features and to include the new pump in data communication with the Santa Rosa Subregional Water Reuse Facility.

Cost

The Rohnert Park Pump Station modifications are estimated to cost approximately $700,000 at 2007 prices.

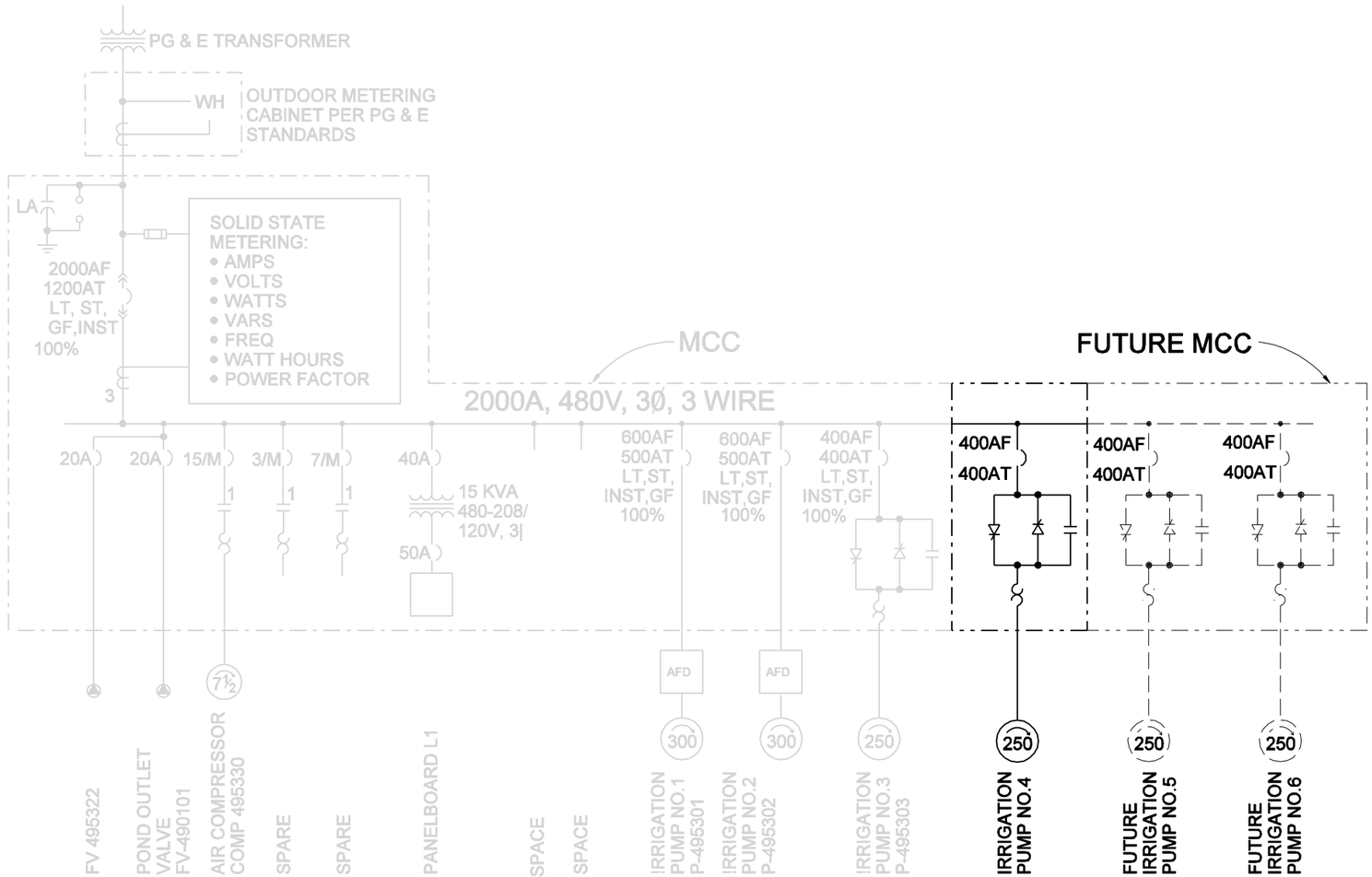

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FIGURE 6
ROHNERT PARK PUMP STATION
ONE LINE DIAGRAM

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PCP 495300
ON JL 495300
LAL 495301 (3)
TAH 495331 AIR
OP 495300 OPERATOR INTERFACE
QA 495301 (3) PUMP FAIL
HS 495303 (4) CS PUMP SEQ SELECT 3-4-5-6
HS 495301 (2) VS PUMP LEAD SELECT 1-2
PAH 495301 (3) PUMPS
PDAH 495310 FILTERS
HS 495300 TEST
HS 495300 ACK
HS 495300 RESET
QA 495325 SURGE TANK TROUBLE
RADIO TELEMETRY
TO/FROM LAGUNA PLANT
PROGRAMMABLE LOGIC CONTROLLER (PLC) PLC 495300
UPS 495300 UNINTERRUPTABLE POWER SUPPLY
UPS POWER
120V
SMP 495300 SECURITY PANEL
INTRUSION ZS 495335 (2)
TROUBLE
REMOTE
HS 490101 OC
ZL 490101 OC
AUTO RUN ON
MOTOR HI TEMP ALARM
FAIL
LSL 495301 (3)
AUTO MODE
PUMP LOCKOUT
MOTOR HI TEMP ALARM
HS 495322 OCA
ZL 493522 OC
REMOTE SYSTEM
PIC 495318
QA 495300 PLC FAIL
PAL 495318
FAH 495319
FILTERS DIRTY
FROM B POND OR EB PUMPS
TSH 495331 AIR ON FAIL
AUTO RUN
RUN AT PRESET FIXED SPEED
TO WILFRED PIPELINE
AFD 495301 (2)
POWER ON
MOTOR TRIP
FLHH MTD
SY 1/E
JL LR HS OOA SI SHK
RESET HS MOTOR ON QL AFD FAIL QL KOI TLH MTD
480V, 3Ø
ZS 490101 OC
LOR HS 490101 OSC HS 490101 E FLP FV 490101
480V
LCP 490103 INTRUSION ZS 490103 LT 490103
120V
NC
PONCIA POND INTAKE
NO
NC
NO
PCV 495308
PCV-495321
HS 495322 LOR
ZS 495322 OC
HS 495322 OSC
E FLP 480V
FV 495322
LE 495301
TE 495301 MTD
PI 495301
PSH 495301
FSL 495301
120V
AS P495301
LE 495302
TE 495302 MTD
PI 495302
PSH 495302
FSL 495302
AS P495302
LE 495303
TE 495303 MTD
PI 495303
PSH 495303
CS-1 P495303 IRRIGATION PUMPS
LE 495304
TE 495304 MTD
PI 495304
PSH 495304
CS-2 P495304 IRRIGATION PUMP
PDSH 495311
LCP 495311 FILTER FLUSH CONTROL PANEL
PDSH 495310
PI 495309
F 495311
FILTERS (5)
FC FV 495311 (5)
PI 495318
PT 495318
FIT 495319
FQI 495319
FE 495319
FUTURE
ROHNERT PARK REUSE PIPELINE
FILTERS (2)
BACKWASH TO SEWER
SILENCER
S FC FV 495326 PI 495325
S FC FV 495325 LE 495325
T 495325 SURGE TANK
SIGHT GLASS
DR
LCP 495325 SURGE SYSTEM CONTROL PANEL
POWER OO HS LLH QL AIR ADD
ON JL LLL QL AIR VENT
(4)
120V
NOTES:
NO = NORMALLY OPEN
NC = NORMALLY CLOSED
TO LAGUNA DE SANTA ROSA
RESET HS 495330 OFF/AUTO HS 495330 OIL PLL 495330
1 MCC START/STOP
PUMP LOCKOUT
ON QL 495330 OIL PSL 495330 CS-1 PS 495330 PI 495330
COMP 495330 AIR COMPRESSOR
480V, 3Ø
T 495330 AIR RECEIVER
AHP
AIR LOCKOUT VALVE, TYP
AUTOMATIC DRAIN TRAP
DR
ON QL 495303
OOA HS 495303
MCC (6)
MTD TLH 495303
RESET HS 495303 MTD
MOTOR TRIP QL 495303

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FIGURE 7
ROHNERT PARK PUMP STATION PROCESS FLOW DIAGRAM

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Roberts Lake Road Pressure-reducing Station

When the Rohnert Park Pump Station is expanded and a storage tank is built in the eastern Rohnert Park area, a pressure-reducing station would be required on Santa Rosa Avenue at the connection of the Rohnert Park system to the Santa Rosa system because the Rohnert Park system will operate at approximately 45 psi higher pressure. The station would have a capacity of 4 mgd.

A 10-inch diaphragm-actuated globe valve could be used. The valve would be installed in a buried vault, approximately 5 feet long by 5 feet wide with a traffic-rated cover sized to allow removal of the valve.

Alpha Farm Power Generation/Pressure-reducing Station

Capacity/Hydraulics

The peak flow rate from the GPL to the Urban Reuse System is anticipated to be approximately 15 to 20 mgd. The normal operating pressure in the GPL is higher than is necessary to supply the proposed storage tanks, so a pressure-reducing station would be required.

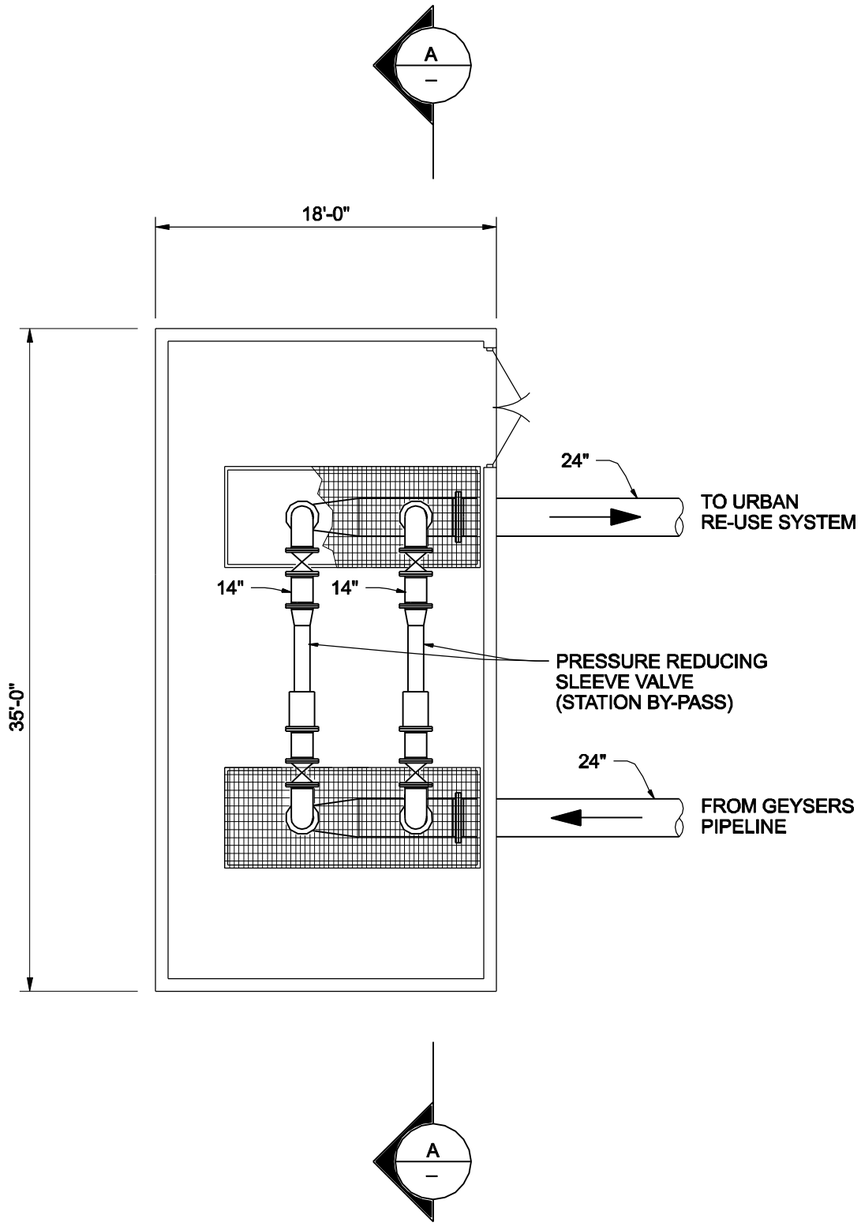
The GPL is pressurized by pumps at the Llano Pump Station. At Llano, mixed variable-speed and constant-speed pumps are automatically controlled to vary the pumping rate as required to maintain a constant level in the wet well of the Bear Canyon Pump Station. At Llano Pump Station, higher pressures are required to force higher flows through the long pipeline to Bear Canyon.

At the minimum design flow of 5 mgd, the hydraulic grade line (HGL) elevation at the pump station is almost the same as the water level in the Bear Canyon wet well, 380 feet, which corresponds to a pump discharge pressure of 125 psi at Llano Pump Station. At the maximum design flow (40 mgd to Red Winery Road and 16 mgd to the Geysers), the HGL elevation at Llano Pump Station would be approximately 600 feet, which corresponds to a pump discharge pressure of 220 psi. The HGL of the Urban Reuse System will be only 275 feet, so reducing the pressure from the GPL at least 105 feet (45 psi), and perhaps as much as 325 feet (140 psi) will be necessary.

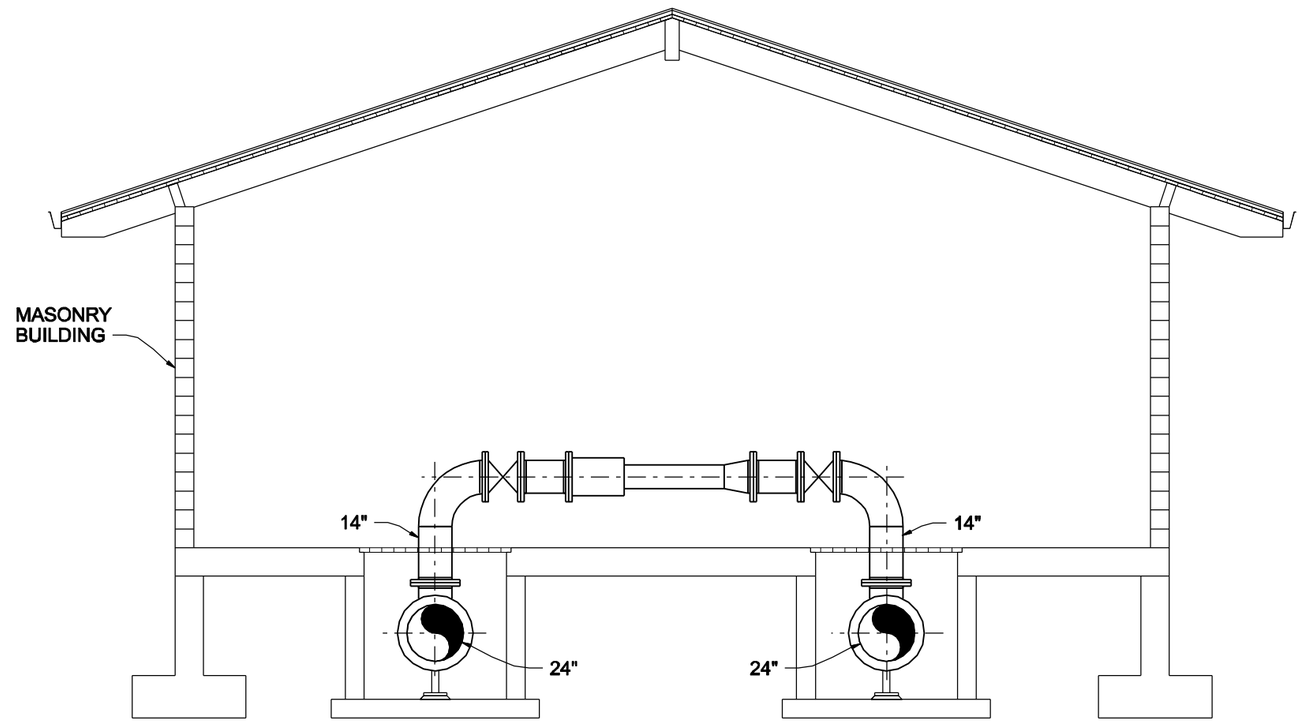
Two types of pressure-reducing stations could be used. The simplest would have a pressure-reducing valve or possibly two valves in parallel, enclosed in a vault or small building. Alternatively, the pressure-reducing station could use hydroelectric turbines to reduce the pressure and, at the same time, generate power.

Conventional Pressure-reducing Station

A conventional pressure-reducing station is shown on Figure 8. Two parallel pressure-reducing valves are shown. Each is assumed to have 20-mgd capacity. Because of the large pressure reduction required when the GPL pressure is high, the pressure-reducing valves are assumed to be sleeve valves. Although more expensive than standard diaphragm-actuated globe valves, sleeve valves are more durable and are not prone to cavitation



PLAN
1/8"=1'-0"



A SECTION
3/16"=1'-0"

FIGURE 8
PRESSURE REDUCING STATION
PLAN

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damage like globe valves. The sleeve valves can be noisy when operating, so they should be installed in a vault or a masonry building, as shown.

Hydroelectric Pressure-reducing Station

Hydroelectric turbines have been used as pressure-reducing stations. They capture some of the energy that the high-pressure water releases as its pressure is reduced. Conventional pressure-reducing stations convert that energy to noise and heat, and they recover none of it. Figures 9 and 10 show a hydroelectric pressure-reducing station. The figures reflect a turbine/generator unit manufactured by the Cornell Pump Company. The turbine is a pump with a modified impeller, and the generator is an induction motor. High-pressure water is fed through the turbine in the direction opposite to that of a pump to spin the induction motor. When rotated faster than its synchronous speed, the induction motor becomes a generator and produces power.

The hydroelectric pressure-reducing station with three generators, 6.5 mgd each, designed for a 100-foot pressure drop, capable of producing 70 kilowatts each is shown on Figures 9 and 10. A conventional pressure-reducing station would also be included in the building in case electrical malfunctions prevent turbine operation or the demand exceeds the capacity of the turbines. Because the station would be able to meet the water demand with or without the turbines, no redundant turbine/generators are shown.

The turbines cannot operate over the wide a range of pressures that would occur on the GPL. Pressure control valves keep the turbines within their operating range. The control valve on the outlet manifold would keep the pressure on the outlet from exceeding the allowable limit for recycled water pipelines in the City, while maintaining an outlet pressure that is within the operating range of the turbine. If the pressure in the GPL is too high because of large demands, the control valve on the inlet manifold would reduce the pressure to match the requirements of the turbines.

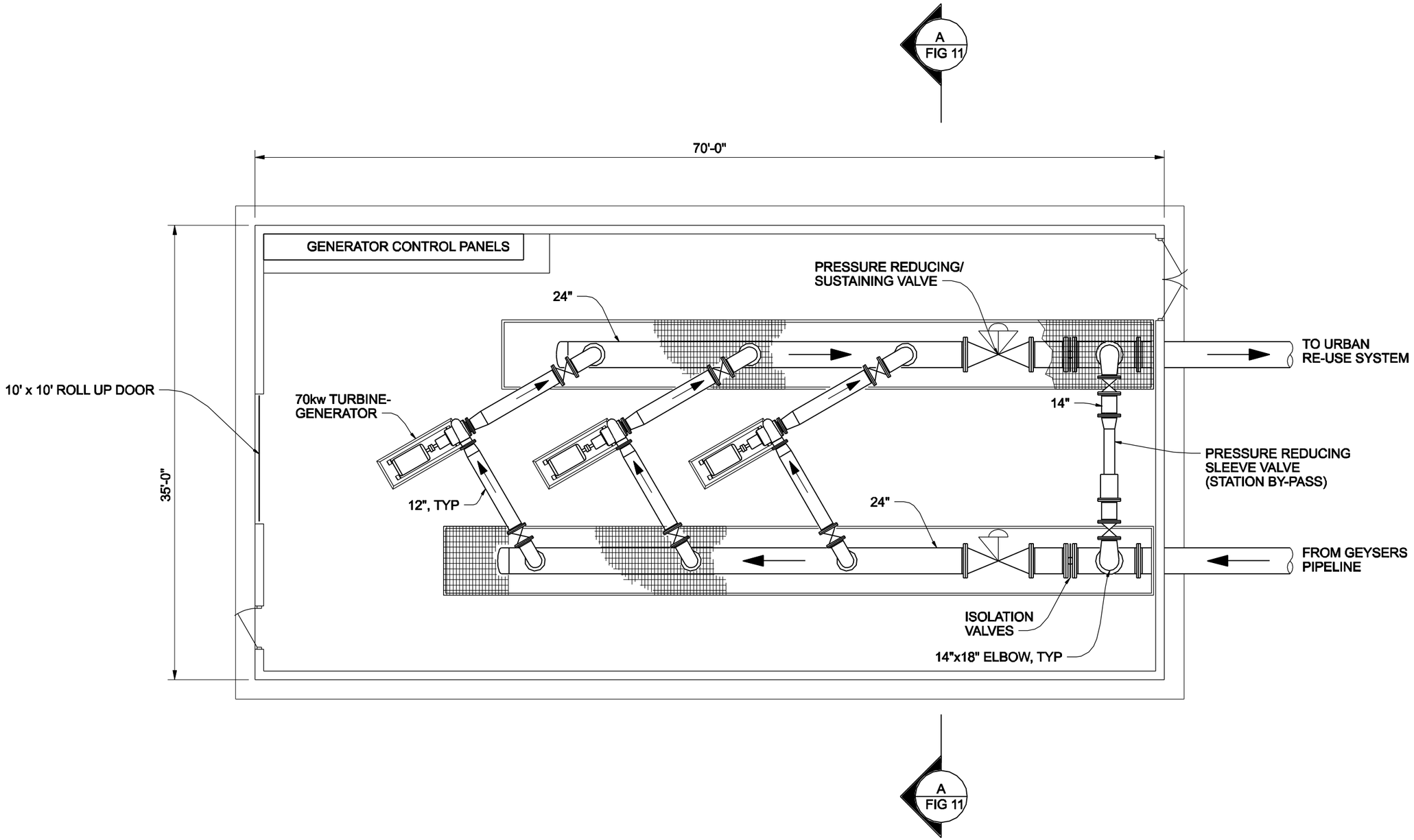
The station would also have a pressure-reducing valve that bypasses the turbines. This valve would enable the station to supply water to the Urban Reuse System if the generators are inoperable. A sleeve valve is recommended for this service. Sleeve valves withstand the high pressure reductions that will be required at this facility better than diaphragm-actuated globe valves. Polyjet brand sleeve valves are used in the GPL pump stations as pressure-regulating and pressure-relief valves.

Civil/Structural

The equipment would be housed in a masonry building, approximately 35 feet by 70 feet. Because the turbines and the sleeve valve could be noisy, and because the station would be located in a quiet rural area near the GPL, a masonry building is recommended. Masonry would provide better noise reduction than either a wood frame or metal building.

Mechanical

Each turbine generator would produce approximately 70 kilowatts from a flow of 6.5 mgd (4,500 gpm) at a pressure reduction of 100 feet of head. The bypass pressure-reducing station would allow the station to operate at flows lower than the minimum capacity of the turbines and to operate when one or more of the turbines is inoperable.



PLAN

1/8"=1'-0"

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FIGURE 9
POWER GENERATION /
PRESSURE REDUCING STATION
PLAN

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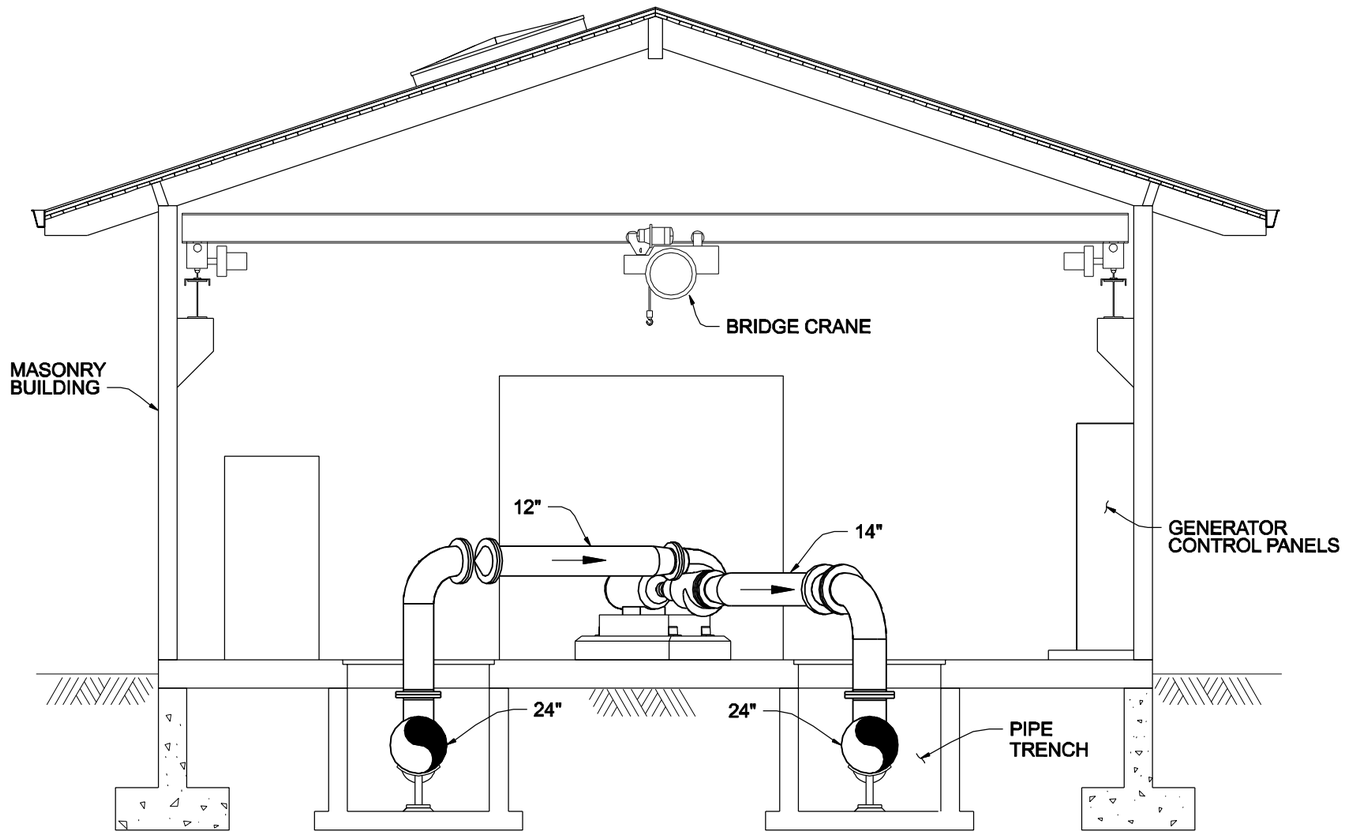

A SECTION
3/16"=1'-0"

FIG 10

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FIGURE 10
POWER GENERATION / PRESSURE REDUCING STATION SECTION

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An overhead bridge crane would facilitate maintenance or removal of the turbine/generators and valves. With the crane, less working space would be required around the equipment, and the building could be somewhat smaller than it would be without the crane.

Electrical and Controls

The generators would be able to start and stop automatically in response to level fluctuations in the storage tanks. An induction generator does not require synchronizing equipment; it receives its magnetizing current from the power grid. The speed of the unit is controlled by the frequency of the power grid. Induction generators cannot be used as stand-alone units. They must be connected to the network at a point where the total output is substantially lower than the minimum demand on the network into which it feeds. The power line along Llano Road meets this criterion, so the pressure-reducing station could be located at a convenient site near the GPL along Llano Road, such as Alpha Farm.

Power Production

The amount of power produced depends on water demand in the Urban Reuse System. The design capacity of the Urban Reuse System is 1,000 MG per year. It is estimated that a hydroelectric station could generate approximately 250,000 kilowatt-hours for each 1,000 MG of recycled water used.

The GPL is pressurized at the Llano Pump Station, and power cost for the pumps will be minimized if the Urban Reuse System's storage tanks are filled during the late night and early morning hours. Because the pressure-reducing station will operate only when the storage tanks are being filled, minimizing the pumping cost will also minimize the revenue from the hydroelectric station due to a lower purchase rate during those hours.

Pacific Gas and Electric Company purchases power at nine different rates throughout the year. The actual purchase rate is calculated by multiplying the base rate of $0.08 per kilowatt-hour by a Time of Delivery Factor. The highest Time of Delivery Factor is during the peak demand period, which is the afternoon and evening hours from June through September. The lowest Time of Delivery Factors occur between 11:00 p.m. and 6:00 a.m., and they vary slightly on a monthly basis throughout the year. From June through September, the Time of Delivery Factor for power generated at night is 0.626. Multiplying the base rate by the Time of Delivery Factor results in an actual rate of $0.05 per kilowatt-hour. The factor is slightly lower in the spring, and slightly higher in the fall, but for estimating purposes, the assumed average rate is $0.05 per kilowatt-hour.

At the estimated average rate of $0.05 per kilowatt-hour, the station would produce approximately $13,000 in annual gross revenue. The gross revenue would be less than 1 percent of the additional cost required to build the hydroelectric station. Therefore, if the City were to build the hydroelectric station, it would not be for economic benefit alone.

Cost Comparison

The hydroelectric pressure-reducing station is estimated to cost $3.4 million, and the conventional station is estimated to cost $1.4 million.

Optional Connection to the Laguna Plant

To minimize the amount of water sent from the storage ponds to the SRURP, connection to the GPL has been preferred. Recycled water from the Laguna Plant could be diverted directly into this pipeline, thereby avoiding the ponds. With the recent implementation of the Geysers Expansion Project, more water from storage ponds will be diverted to the GPL during the summer, making this advantage less significant. In addition, the Geysers Expansion Project delivery schedule allows less flexibility in the GPL maintenance schedule. As an alternative to the GPL, the SRURP could be supplied from E Pump Station through the existing low-pressure recycled water pipeline that is parallel to the GPL along Llano Road. In either case the SRURP would receive a blend of water from the Laguna Plant and storage ponds that would be filtered.

E Pump Station

E Pump Station currently has sufficient capacity to supply the SRURP in addition to other demands. Currently planned modifications include replacing one of the constant-speed pumps with a variable speed pump. With a variable-speed pump in place, it will be easier to meet low flow demands that could occur initially.

Alpha Farm Pump Station

The hydraulic grade line of the recycled water pipeline is approximately elevation 110 feet at Alpha Farm. Water from the pipeline must be boosted 165 feet to the hydraulic grade line of the Urban Reuse System. Approximately 300 horsepower will be required to pressurize 14 mgd.

At the Alpha Farm site, a pump station could be constructed near the pipeline in Llano Road by the filtration and treatment facilities. The pump station could be built using slab-on-grade construction with vertical pumps installed in suction cans. The pump station would have a masonry building for noise reduction and protection of the equipment. Skylights would be provided above the pumps for pump removal and replacement. This arrangement is shown on Figures 11 and 12.

Three pumps are shown, 7-mgd capacity each: two duty pumps and one redundant unit. Adjustable-frequency drives would be necessary to allow the pumps to operate over a range of flows. A hydropneumatic surge tank would probably be required to protect the system from pressure surges in the event of power failure at the pump station. The tank would also be necessary to allow the pump station to operate at very low flows, as could occur initially. When recycled water ponds are constructed, the hydropneumatic tank would not be needed for low flow operation, but it could still be necessary for surge protection.

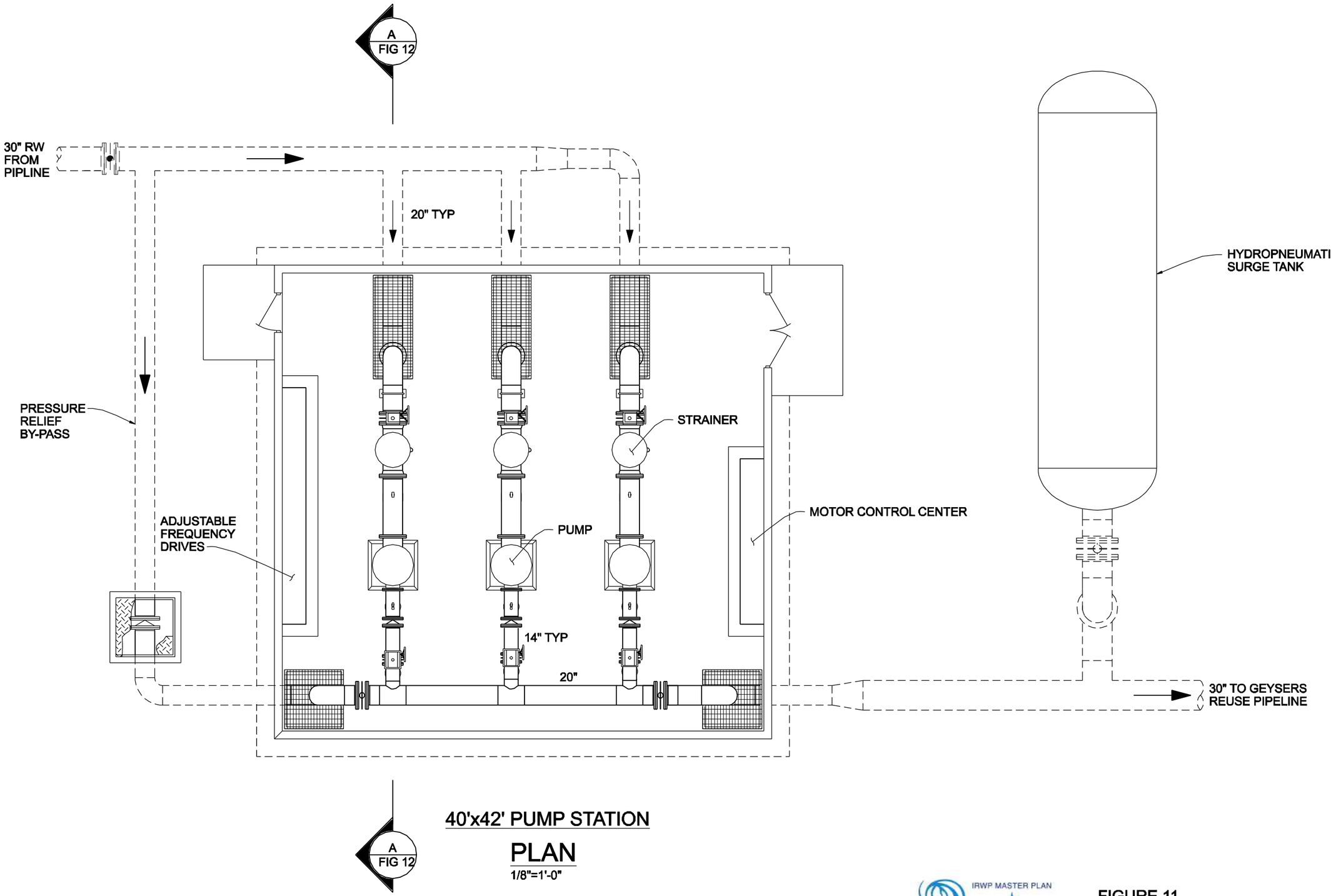
Cost

The Alpha Farm Pump Station is estimated to cost approximately $4,000,000 at 2007 prices.

Power Consumption

It would require less power to provide recycled water to the SRURP from Alpha Farm Pump Station than from the GPL. The Alpha Farm Pump Station would boost the pressure

only to the level necessary for the reuse system, but the Llano pumps must boost the pressure to meet the requirements of the GPL, a minimum of 120 feet higher than the 165 feet needed for the SRURP. Approximately 500,000 kilowatt-hours of power would be required to boost flow to supply the 1,000-MGY project the additional 120 feet in the GPL. As the flow in the GPL increases, the pipeline pressure must also increase, and difference in power consumption would also increase well above the calculated 500,000 kilowatt-hours minimum value. Approximately half of the 500,000 kilowatt-hours could be recovered with a generator. The Alpha Farm Booster Pump Station would use approximately 250,000 kilowatt-hours.



40'x42' PUMP STATION

PLAN

1/8"=1'-0"

IRWP MASTER PLAN

Urban Reuse

FIGURE 11
ALPHA FARM
PUMP STATION PLAN

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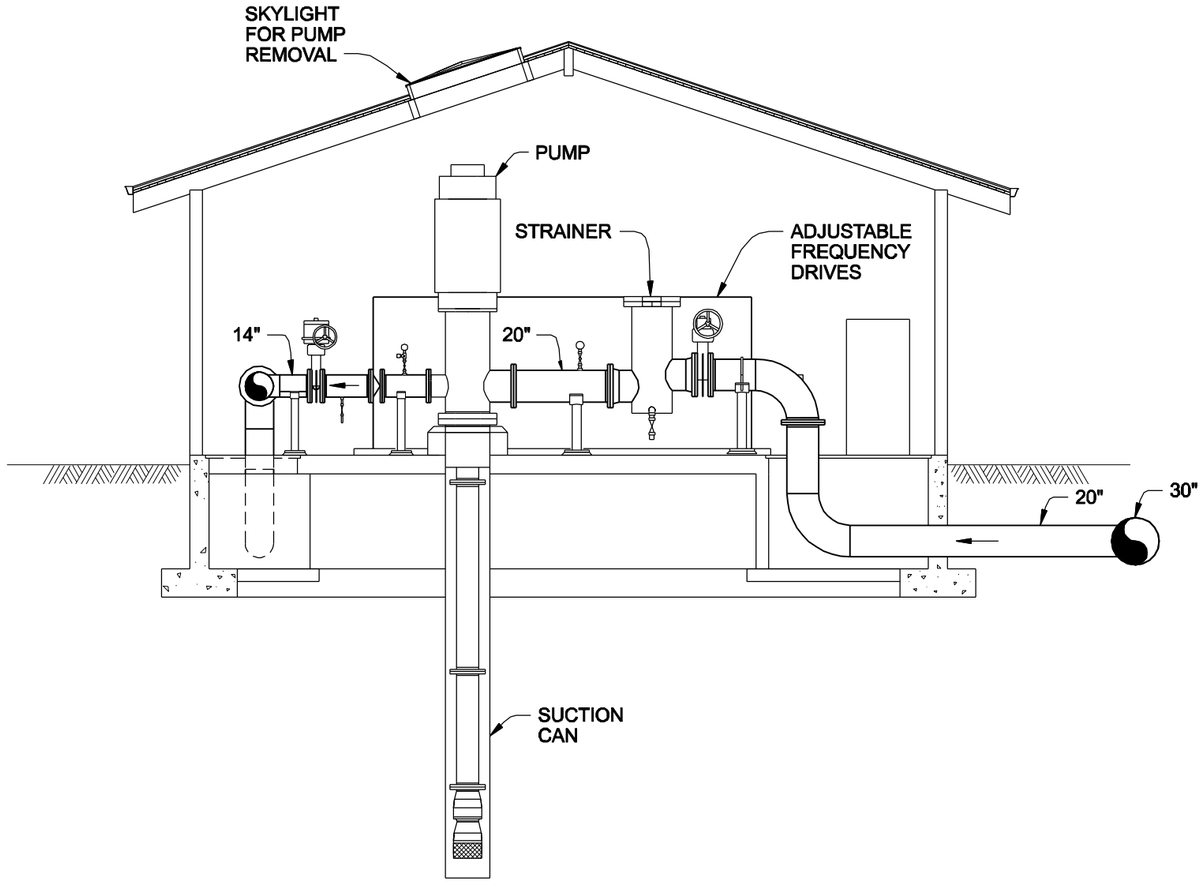

A SECTION
1/8"=1'-0"

FIG 11

IRWP MASTER PLAN
Urban Reuse

FIGURE 12
ALPHA FARM
PUMP STATION SECTION

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